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Patentanmeldung Nr. Patent application No. Demande de brevet n°

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For the President of the European Patent Office

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If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Powder coating compositions

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POWDER COATING COMPOSITION

Field of the invention

The present invention relates to the field of powder coating compositions comprising a β-hydroxyalkylamide compound and a polymer comprising functional groups capable of reacting with β-hydroxyalkylamide units. The present invention relates to a novel powder paint composition. The present invention relates to the use of a certain compound as deceleration agent in powder paints.

Prior art

Powder coating compositions comprising β-hydroxyalkylamide compounds are known from US 4,801,680. In such powder coating compositions β-hydroxyalkylamides are combined with polymers comprising functional groups capable of reacting with β-hydroxyalkylamide units. Such powder coating compositions are also commercially available. One of the problems with the use of β-hydroxyalkylamide compounds in powder coating compositions is that the reactivity of the powder coating composition is too high, causing for example a low blister limit, especially when relatively thick coating layers are applied. Furthermore, the flow of the powder coating composition once applied to the substrate and heated to spread over the surface may not be sufficient for several applications. This can result in the formation of a so-called orange peel effect.

A known method to overcome these disadvantages is to adapt the polymers used in the powder coating composition, as for example disclosed in WO 01-20505.

Although a higher blister limit may be reached, modification of the polymer also results in the modification of the chemical and mechanical properties of the resulting coating, for example decrease in flexibility or solvent resistance. These effects are mostly not desirable. Another undesirable effect may be due to a decrease of the glass transition temperature (Tg) of the polymer. A lower Tg can result in a decreased powder stability upon further processing the composition in an extruder or upon storage of the powder paint composition.

The object of the present invention is to provide a powder

coating composition comprising β-hydroxyalkylamide compounds resulting in a coating with a high blister limit whilst having good mechanical properties.

Brief description of the invention

Surprisingly it has been found that a powder coating composition comprising at least:

(a) a thermosetting polymer comprising functional groups capable of reacting with β-hydroxyalkylamide units

(b) a compound comprising β-hydroxyalkylamide units

(c) a deceleration agent, capable of reversibly blocking the functional groups of polymer (a), present in an amount sufficient to block at least 5 % of the total amount of functional groups of polymer (a) capable of reacting with β-hydroxyalkylamide units,

results in a coating having a higher blister limit, showing good mechanical properties.

Further advantages may be a longer gel time, increased UV resistance, increased heat resistance, increased chemical resistance, improved flow, improved boiling water/humidity resistance, improved pigment dispersion, good mechanical properties, for example flexibility.

Detailed description of the invention

The powder paint composition according to the invention comprises a thermosetting polymer (a) comprising functional groups capable of reacting with β-hydroxyalkylamide units.

The polymer is preferably a polymer containing functional carboxylic acid groups or containing functional anhydride groups as functional groups capable of reacting with β-hydroxyalkylamide units. Suitable polymers include for example a polyester, a polyacrylate, a polyether (for example a polyether based on bisphenol or a phenol-aldehyde novolak), a polyurethane, a polycarbonate, a trifluoroethylene copolymer or a pentafluoropropylene copolymer, a polybutadiene, a polystyrene or a styrene maleic anhydride copolymer.

Preferably the polymer (a) is a polyester, more preferred a carboxylic acid group-containing polyester. The carboxylic acid group-containing

polyester contributes flexibility, impact resistance, and corrosion resistance to the powder coating composition of the present invention. Among the suitable polyesters are those based on a condensation reaction of linear aliphatic, branched aliphatic and cyclo-aliphatic polyols with aliphatic, cyclo-aliphatic and/or aromatic poly carboxylic acids and anhydrides. The ratio of polyol and acids or anhydrides is such that there is an excess of acid or anhydride over alcohol (so as) to form a polyester which has free carboxylic groups or anhydride groups.

The polyester may comprise units of for example isophthalic acid, terephthalic acid, 2,6-naphthalene dicarboxylic acid, 4,4'-oxybisbenzoic acid, 3,6-dichloro phthalic acid, tetrachloro phthalic acid, tetrahydro phthalic acid, trimellitic acid, pyromellitic acid, hexahydro terephthalic acid (cyclohexane dicarboxylic acid), hexachloro endomethylene tetrahydro phthalic acid, phthalic acid, azelaic acid, sebacic acid, decane dicarboxylic acid, adipic acid, succinic acid, maleic acid and fumaric acid. These acids may be used as such, or, in so far as available as their anhydrides, acid chlorides or lower alkyl esters. Also mixtures of any of the mentioned polyesters may be used. Preferably, the polyester is based on at least one of isophthalic acid and/or terephthalic acid. In this case, when also using other carboxylic acids, it is preferred, to use the other carboxylic acids in amounts of up to for example 25 mol% of the total amount of carboxylic acids. Also trifunctional or higher functional acids may be used, such as trimellitic acid or pyromellitic acid. These tri or higher functional acids may be used to obtained branched polyesters or used as end groups of the polyester. In case they are used to obtain branched polyesters, usually only small amounts are applied in polyester synthesis, to avoid gelation.

Hydroxy carboxylic acids and/or optionally lactones can also be used, for example, 12-hydroxy stearic acid, hydroxy pivalic acid and ε-caprolactone.

Monocarboxylic acids may, if desired, be used in minor amounts. Examples of these acids are benzoic acid, tert.-butyl benzoic acid, hexahydro benzoic acid and saturated aliphatic monocarboxylic acids.

Useful polyalcohols, in particular diols, reactable with the carboxylic acids to obtain the polyester include aliphatic diols. Examples are ethylene glycol, propane-1,2-diol, propane-1,3-diol, butane-1,2-diol, butane-1,4-diol, butane-1,3-diol, 2,2-dimethylpropanediol-1,3 (= neopentyl glycol),

hexane-2,5-diol, hexane-1,6-diol, 2,2-bis-(4hydroxy-cyclohexyl)-propane (hydrogenated bisphenol-A), 1,4-dimethylolcyclohexane, diethylene glycol, dipropylene glycol, 2,2-bis[4-(2-hydroxy ethoxy)-phenyl] propane, the hydroxy pivalic ester of neopentyl glycol, 2-ethyl, 2-butyl propanediol-1,3 (=butylethylpropane diol) , 2-ethyl, 2-methyl propanediol-1,3 (= ethylmethylpropane diol) and 2-methylpropanediol-1,3 (MP-Diol).

Tri- or higher functional alcohols may be used in small amounts in order to obtain branched polyesters. Examples of suitable polyols include glycerol, hexanetriol, trimethylol ethane, trimethylol propane tris-(2-hydroxyethyl)-isocyanurate, penta erythritol and sorbitol.

The polyester may be prepared according to conventional procedures by esterification or transesterification, optionally in the presence of customary esterification catalysts for example dibutyltin oxide or tetrabutyl titanate. Preparation conditions and the COOH/OH ratio can be selected so as to obtain end products that have an acid number and/or a hydroxyl number within the targeted range of values.

Generally, the polymer (a) has an acid value between 20 and 120 mg KOH/gram resin and more preferably between 20 and 80 mg KOH/gram resin.

The number average molecular weight (Mn) of the polymer (a) may be for example between about 1,000 and about 7,000, preferably between about 1,400 and 6,000.

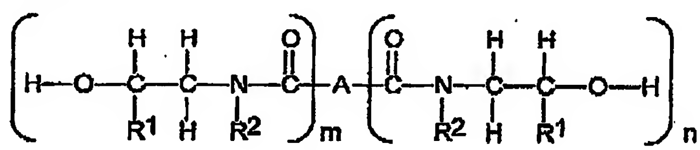
The polymer (a) may be a crystalline, semi-crystalline or amorphous solid at room temperature. In case the polymer is crystalline, it has a melting temperature Tm, in case it is semi-crystalline it has a melting temperature Tm and a glass transition temperature Tg, in case it is amorphous, it has a glass transition temperature Tg. These temperatures can be determined by use of a differential scanning calorimeter (DSC) using standard DSC-techniques, for example a DSC 821-E from Mettler Toledo. The DSC-measurement is performed with a heating and cooling rate of 5°C/min.

Preferably, the polymer (a) is an amorphous solid at room temperature. The glass transition temperature, Tg, of the polymer may range between 20°C and100 °C, preferably from about 35 °C to about 85 °C, more preferably from about 40 °C to about 75 °C.

The polymer (a) may have a viscosity lower than 200 Pa.s (measured at 160°C, Rheometrics CP 5), preferably lower than 150 Pa.s.

Another ingredient in the powder coating compositions of the present invention is a compound comprising β-hydroxyalkylamide units (b). Compound (b) can be a curing agent for polymer (a). The hydroxyl functionality of the β-hydroxyalkylamide should be on an average basis at least two, preferably greater than two. The hydroxyl functionality of the β-hydroxyalkylamide preferably should be lower than 10, even more preferably lower than 6 and most preferably equal to or lower than 4. According to a preferred embodiment of the invention the hydroxyl functionality of the β-hydroxyalkylamide ranges from greater than 2 up to and including 4.

Examples of suitable β-hydroxyalkylamide compounds (b) are disclosed in US 4,801,680, which content is hereby incorporated by reference. More specifically, suitable β-hydroxyalkylamide compounds are depicted structurally as follows:

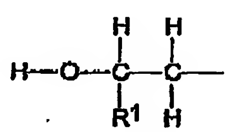


(I)

wherein

R_1 is H or C_1 -C_5 alkyl;

R_2 is H, C_1 -C_5 alkyl or



wherein R_1 is as described above;

A is a bond, monovalent or polyvalent organic radical derived from a saturated, unsaturated or aromatic hydrocarbon including substituted hydrocarbon radicals containing from 2 to 20 carbon atoms;

m is equal to 1 to 2;

n is equal to 0 or 2;

and m+n is at least 2.

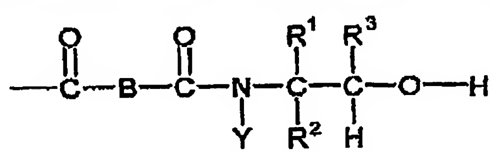
Preferably, A is an alkylene radical -$(CH_2)_x$- where x ranges from 2 to 12. Preferably, x ranges from 4 to 10.

Preferably m+n is greater than 2, more preferably within the range of from 2 up to and including 4.

The above β-hydroxyalkylamide compound can be prepared by reacting a lower alkyl ester or mixture of esters of carboxylic acids with a beta-hydroxyalkylamine at a temperature ranging from ambient temperature up to about 200° C, depending on the choice of reactants and the presence or absence of a catalyst. Suitable catalysts, include base catalysts such as sodium methoxide, potassium methoxide, sodium butoxide, potassium butoxide, sodium hydroxide, potassium hydroxide and the like, present in amounts of about 0.1 to about 1 percent by weight based on the weight of the alkyl ester.

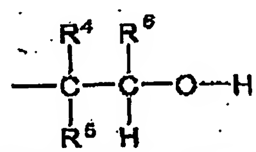
Some of the above-mentioned compounds are commercially available, for example N,N,N',N'-tetrakis-(2-hydroxyethyl)-adipamide (Primid XL-552), N,N,N',N'-tetrakis-(2-hydroxypropyl)-adipamide (Primid QM 1260). Other beta-hydroxylamides are described in the literature, for example, those mentioned in the patents US-A-4727111, US-A-4788255, US-A-4076917, or in the patent applications EP-A-322834 and EP-A-473380.

Also larger β-hydroxyalkylamide compounds are suitable for the composition according to the present invention. Examples of such β-hydroxyalkylamide compounds are the polyesteramides as described in WO99/16810, which content is incorporated herein by reference. WO99/16810 describes linear or branched condensation polymers containing ester groups and at least one amide group in the backbone, having at least one hydroxyalkylamide end group and having a weight average molecular mass of > 800 g/mol. An example of a suitable β-hydroxyalkylamide compound (b) is a branched polyesteramide comprising at least two groups according to formula II:



(II)

in which

Y =  , H, $(C_1\text{-}C_{24})$(cyclo)alkyl or $(C_6\text{-}C_{10})$ aryl,

B = $(C_2\text{-}C_{24})$, optionally substituted, aryl or (cyclo)alkyl aliphatic diradical, and R^1, R^2, R^3, R^4, R^5 and R^6 may, independently of one another, be the same or different, H, $(C_6\text{-}C_{10})$ aryl or $(C_1\text{-}C_8)$(cyclo)alkyl radical.

Preferably the β-hydroxyalkylamide according to the invention is a β-hydroxyalkylamide according to formula (I). More preferably, the commercially available β-hydroxyalkylamides are used.

To bring about the most effective cure of the powder coating composition, the equivalent ratio of β-hydroxyalkylamide (hydroxy equivalents) to carboxy-containing polyester (carboxylic acid equivalents) is preferably from about 0.6 to 1.6:1, more preferably from 0.8 to 1.3:1, most preferably from 0.9 to 1.15:1. Ratios outside the range of 0.6 to 1.6:1 are undesirable because of poor cure.

Another essential element of the coating composition according to the invention is the presence of a deceleration agent (c). A deceleration agent is a compound that is capable of slowing down the curing reaction. Also mixtures of deceleration agents may be used. It is essential to the invention that the deceleration agent is capable of reversibly blocking the functional groups of polymer (a). Deceleration agent (c) should be present in an amount sufficient to block at least 5 % of the total amount of functional groups of polymer (a) capable of reacting with β-hydroxyalkylamides. Generally, at most 100 % can be blocked. Preferably between 10 and 50 % is blocked, more preferably between about 15 to about 30 %. The amount of deceleration agent (c) depends on the desired amount of reversibly blocked functional groups in polymer (a) and the amount of functional groups in polymer (a). The person skilled in the art is capable of calculating the desired amounts of deceleration agent (c) based on these data.

Reversible blocking of a functional group can be established in many ways, for example by forming a bond that is only stable within a certain temperature window. Preferably the blocking is reversed within the temperature range of the cure of the powder coating composition according to the invention. The curing temperature of the powder coating composition, the resulting coating may not have the desired properties. The reversible block can be in form of a covalent bond, a hydrogen bridge, an ionic bond, a salt complex and the like. Preferably a salt complex is formed.

Preferably, the deceleration agent (c) is an amine, more preferably an aliphatic amine. According to another preferred embodiment of the invention the deceleration agent is a tertiary amine, more preferably an aliphatic tertiary amine. It must be noted that HALS compounds or TRIBO-compounds as described in for example EP-B-371528, although they are often amines, are not

suitable for use as a deceleration agent, since they are sterically hindered. Due to the sterical hindrance they are not capable to reversibly block the functional groups of polymer (a).

In a preferred embodiment of the invention the deceleration agent (c) is at least one tertiary compound according to formula III and/or IV

$$YR^1R^2R^3 \qquad (III)$$

or

$$(YR^1R^2R^3R^4)^+X^- \qquad (IV)$$

wherein:

Y is N or P,

R^1, R^2, R^3 or R^4 are independently of each other, substituted or unsubstituted carbon chains with 1-50 carbon atoms in the main chain.

X^- is halide.

Y can be nitrogen or phosphorus. It is preferred that Y is nitrogen. In case Y is nitrogen, it is hereinafter referred to an amine compound according to formula III and or IV.

Preferably, R^1, R^2, R^3 or R^4 are unsubstituted carbon chains. Substituted chains may cause sterical hindrance, resulting in the incapability of the compound to reversibly block the functional groups of polymer (a). Preferably at least one of R^1, R^2, R^3 or R^4 is unsubstituted and has at least 8 carbon atoms. This R-group with at least 8 carbon atoms is here and hereinafter referred to as the "long carbon chain". This long carbon chain has preferably 16-20 carbon atoms. The other remaining R-chains R^1, R^2, R^3 or R^4 are independently of each other, substituted or unsubstituted carbon chains with 1-50 carbon atoms in the main chain. They are here and hereinafter referred to as "short carbon chain". Preferably the short carbon chain contains 1-30, more preferred 1-12 carbon atoms. It is preferred to have only one "long carbon chain".

Compounds according to formula III and/or formula IV are known as accelerators in hybrid polyester powder coating systems, as for example disclosed in WO01/68781. It is quite surprising that the same compounds have a decelerating effect in the powder coating composition according to the invention.

A further advantage of compounds according to formula III and/or IV is that their addition increases the tribo-chargeability of the coating composition. This makes it possible to use less or no additional tribo-chargeability

enhancer. In standard coating compositions that are applied onto the substrate by the use of a tribo-gun, a tribo-chargeability enhancer is added. By the use of the additive according to formula III and/or IV to overcome the problem of too fast curing speed, the tribo-chargeability is at the same time increased.

Another advantage is that the resulting coating may have antibacterial and/or antifouling properties.

Examples of compounds according to formula III, with Y being nitrogen are octyldimethylamine, decyldimethylamine, dodecyldimethylamine, tetradecyldimethylamine, hexadecyldimethylamine, octadecyldimethylamine, didodecylmonomethylamine, ditetradecylmonomethylamine, dihexadecylmonomethylamine, di-tallow alkylmonomethylamine, (hydrogenated tallow alkyl)-dimethylamine, trioctylamine, tridecylamine, tridodecylamine or mixtures of any of them.

Preferred compounds in formula III (hydrogenated tallow alkyl)-dimethylamine and hexadecyldimethylamine (also known as palmityldimethylamine).

Examples of formula III with Y being phosphorus are dodecyldiphenylphosphine, decyldiphenylphosphine, octyldiphenylphosphine, trioctylphospine or mixtures of any of them.

Examples of formula IV with Y being nitrogen are octyltrimethyl ammonium halides, decyltrimethyl ammonium halides, dodecyltrimethyl ammonium halides, tetradecyltrimethyl ammonium halides, hexadecyltrimethyl ammonium halides, octadecyltrimethyl ammonium halides, didodecyldimethyl ammonium halides, ditetradecylmonomethyl ammonium halides, dihexadecylmonomethyl ammonium halides, ditallowalkylmonomethyl ammonium halides, trioctyl ammonium halides, tridecyl ammonium halides, tridodecyl ammonium halides or mixtures of any of them.

Examples of formula IV with Y being phosphorus are dodecyltriphenyl phosphonium halides, decyltriphenyl phosphonium halides, octyldiphenyl phosphonium halides, trioctyl phosphonium halides or mixtures of any of them.

Furthermore, the invention relates to a novel use for compounds according to formula III and/or formula IV in polyester powder coatings. It has surprisingly been found that these compounds can be used as deceleration agent

in powder coatings comprising β-hydroxyalkylamide compounds.

In contrast, in polyester-epoxy formulations the amine compounds according to formula III and/or formula IV are used as cure catalysts, as for example is disclosed in WO 01/68781. In polyester-epoxy formulations they accelerate the curing reaction, whilst in the specific case of powder coating compositions comprising β-hydroxyalkylamide compounds they surprisingly act as deceleration agents, resulting in for example a lower blister limit. Other advantages may for example be better pigment dispersion, improved processability of the powder coating composition, better flow during heating of the powder coating composition after application of the powder on the substrate.

The powder coating composition according to the invention can optionally contain pigments, fillers and/or the usual additives, for example degassing agents, flow agents and (light)stabilizers.

Pigments may be inorganic or organic. Suitable inorganic pigments are for example, titanium dioxide, zinc sulphide, iron oxide and chromium oxide. Suitable organic pigments are for example azo compounds.

Suitable fillers are for example metal oxides, silicates, carbonates and sulphates.

Suitable stabilizers are for example primary and/or secondary antioxidants and UV stabilizers for example quinones, (sterically hindered) phenolic compounds, phosphonites, phosphites, thioethers and HALS (hindered amine light stabilizers).

Examples of suitable degassing agents are cyclohexane dimethanol bisbenzoate, benzoin and benzoin derivatives for example as described in WO02/50194.

Other suitable additives are for example additives for improving tribo-chargeability.

The invention also relates to a novel method to prepare powder coating compositions according to the invention. It has been found that one can prepare a powder coating composition according to the invention by a method comprising at least the steps of:

a) producing a polymer (a) having functional groups capable of reacting with β-hydroxyalkylamide units at temperature Tp;
b) adding a deceleration agent (c) to the polymer (a) at temperature Tb,

wherein Tb is equal to or lower than Tp but higher than the Tg or Tm of the polymer, in an amount sufficient to block at least 5 mol% of the functional groups of polymer (a) capable of reacting with β-hydroxyalkylamide units.

The deceleration agent (c) can be added before the polymer (a) is cooled down to below its Tg or Tm, for example at the end of production of the polymer. It is also possible to add the deceleration agent (c) to the polymer (a) and optionally the compound comprising β-hydroxyalkylamide units (b) during production of the powder paint composition. Preferably, the deceleration agent is added before the polymer is cooled down to below its Tg or Tm, since this results in an increased heat stability of the coating.

The process according to the invention can be suitably applied to coating compositions that are powders.

The preparation of a powder coating composition in general is described by Misev in Powder Coatings, Chemistry and Technology (1991, John Wiley) on pp. 224-227. Generally, the components of the composition are premixed, for example by dry blending or drum mixed. The resulting premix is then homogenised at temperatures between about 70 – 150 °C in an extruder. The extrudate is then cooled down and grinded to a powder with a 10-150 μm particle size, resulting in a powder coating composition.

The powder coating composition can be deposited on the substrate by use of a powder gun such as an electrostatic CORONA gun or TRIBO gun. On the other hand, well-known methods of powder deposition such as the fluidised bed technique can be used.

The powder coating composition according to the invention can be cured by the generally known curing techniques, for example thermal curing or curing with infrared radiation. Thermal curing can for example take place in a gas oven or in an electrical oven. The temperature during curing can be tailored to one's needs, depending on the coating composition to be cured and/ or on the substrate. A suitable temperature range may be between 140 and 200 °C. The time necessary to obtain a coating with acceptable coating properties can be chosen between wide ranges, for example between 4 to 30 minutes, preferably between 6 and 10 minutes. Generally, the higher the curing temperature, the shorter the curing time can be.

The invention also relates to an entirely or partly coated

substrate wherein the coating is obtained from curing the coating composition according to the invention.

The present invention is illustrated with reference to the following, non-limiting examples.

Examples

Preparation of the polymers

For the preparation of the following polymers (A-C) URALAC P 865 has been used as a base resins. URALAC P 865 is a carboxylic functional polyester, available from DSM Coating Resins, with acid value range AV= 33-37 mgKOH/g, Tg= 56 °C. URALAC P865 was synthesised by direct esterification at a temperature range of between 220 °C and 270 °C. After synthesis, the polyester was split in three parts, being processed further into resins A, B and C respectively.

Resin A

The first part of the lab batch was cooled down to room temperature.

Resin B

2% of hexadecyldimethylamine (HDMA) was added to the second part at about 195 °C. The mix was stirred for 30 min at 195°C. Then the resin was cooled down to room temperature.

Resin C

3.25% of hexadecyldimethylamine (HDMA) was added to the third part at about 195 °C. The mix was stirred for 30 min at 195°C. Then the resin was cooled down to room temperature.

Examples I, II, III and Comparative Experiment A.

Four white pigmented powder coating compositions containing the following ingredients were formulated as described in Table 1 (in parts by weight).

Table 1	Comparative experiment A	Example I	Example II	Example III
Resin A	190	190	*	*
Resin B	*	*	190	*
Resin C	*	*	*	190
HDMA	*	3.87	*	*
Primid XL-552	10	10	10	10
Kronos 2160	100	100	100	100
Resiflow PV 5	3	3	3	3
Benzoin	8.333	8.333	8.333	8.333

The ingredients were mixed in a premixer, homogenised and extruded in a double screw extruder Prism. The extrudate was milled and sieved to a powder with particle size less than 90µ. The powders were sprayed electrostatically on an aluminium substrate (AL-46). The coated substrates were cured for 10 minutes at 180°C.

The properties of the resulting coated substrates are reported in Table 2.

Table 2	Comparative Experiment A	Example I	Example II	Example III
Gel time at180 °C, sec[1]	220	248	259	308
Flow [2]	6	6+	7	8
Degassing limit (µm)	120	129	140	154
Impact[3]				
- 60ip/75µ initial	Pass	Pass	Pass	Pass
- 60ip/75µ after 1 day	Pass	Pass	Pass	Pass
Heat Stability (b*)				
b* initial	0.6	0.5	0.7	1.0
b* 60' 220 °C	5.7	5.6	3.6	4.1
db* 60' 220 °C	5.1	5.1	2.9	3.0
b* 10' 240 °C	2.4	2.5	2.4	2.6
db* 10' 240 °C	1.7	2.0	1.7	1.6
QUV-B resistance[5], hrs	450	462	504	509

[1] DIN55990

[2] Flow is determined visually on is 1-10 with 10= best

[3] ASTM D2794

[4] The colour properties of the powder coating can be expressed in a b*-value, measured with a Dr Lange Micro Color Meter measured at a layer thickness of 60 µm according to ISO 7724.

[5] 4 hrs UV-B 50°C / 4 hrs cond. 40°C

The results show that the addition of the deceleration agent leads to improvement of the coatings properties. Also is seen that in case the deceleration agent is added at the end of the polymer synthesis, the heat stability of the resulting coating is also improved.

CLAIMS

1. A powder coating composition comprising at least
   (a) a thermosetting polymer having functional groups capable of reacting with β-hydroxyalkylamide units
   (b) a compound comprising β-hydroxyalkylamide units
   (c) a deceleration agent, capable of reversibly blocking the functional groups of polymer (a), present in an amount sufficient to block at least 5 % of the total amount of functional groups of polymer (a) capable of reacting with β-hydroxyalkylamide units
2. Powder coating composition according to claim 1, wherein deceleration agent (c) is an aliphatic amine.
3. Powder coating composition according to any one of claims 1-2, wherein polymer (a) is an acid functional polyester.
4. Process for the preparation of a powder paint composition according to any one of claims 1-3 comprising at least the steps of:
   a) producing a polymer (a) having functional groups capable of reacting with β-hydroxyalkylamide units at temperature Tp;
   b) adding a deceleration agent (c) to the polymer at temperature Tb, wherein Tb is equal to or lower than Tp but higher than the Tg or Tm of the polymer, in an amount sufficient to block at least 5 mol% of the functional groups of the polymer (a) capable of reacting with β-hydroxyalkylamide units.
5. Process according to claim 4, wherein the deceleration agent is added before the polymer is cooled down to below its Tg or Tm.
6. Use of a tertiary compound according to formula III and/or IV:

$$YR^1R^2R^3 \qquad (III)$$

$$(YR^1R^2R^3R^4)^+X^- \qquad (IV)$$

wherein:

Y is N or P;

R^1, R^2, R^3 or R^4 are independently of each other, substituted or unsubstituted carbon chains with 1-50 carbon atoms in the main chain;

X^- is halide;

as deceleration agent in powder coating formulations comprising β-hydroxyalkylamide compounds.

7. Process for curing a powder coating composition according to any one of claims 1-3 or obtained by the process according to any one of claims 4-5 whereby the powder coating composition is applied to a substrate and then cured.

8. Entirely or partly coated substrate wherein the coating is obtained from curing the coating composition according to any one of claims 1-3 or obtained by the process according to any one of claims 4-5.

ABSTRACT

The present invention relates to a powder coating composition comprising at least a thermosetting polymer having functional groups capable of reacting with β-hydroxyalkylamide units, a compound comprising β-hydroxyalkylamide units, a deceleration agent, capable of reversibly blocking the functional groups of polymer, present in an amount sufficient to block at least 5 % of the total amount of functional groups of polymer capable of reacting with β-hydroxyalkylamide units. The present invention relates also to the use of a certain compound as deceleration agent in powder paints.

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